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PATENT & TRADEMARK OFFICE

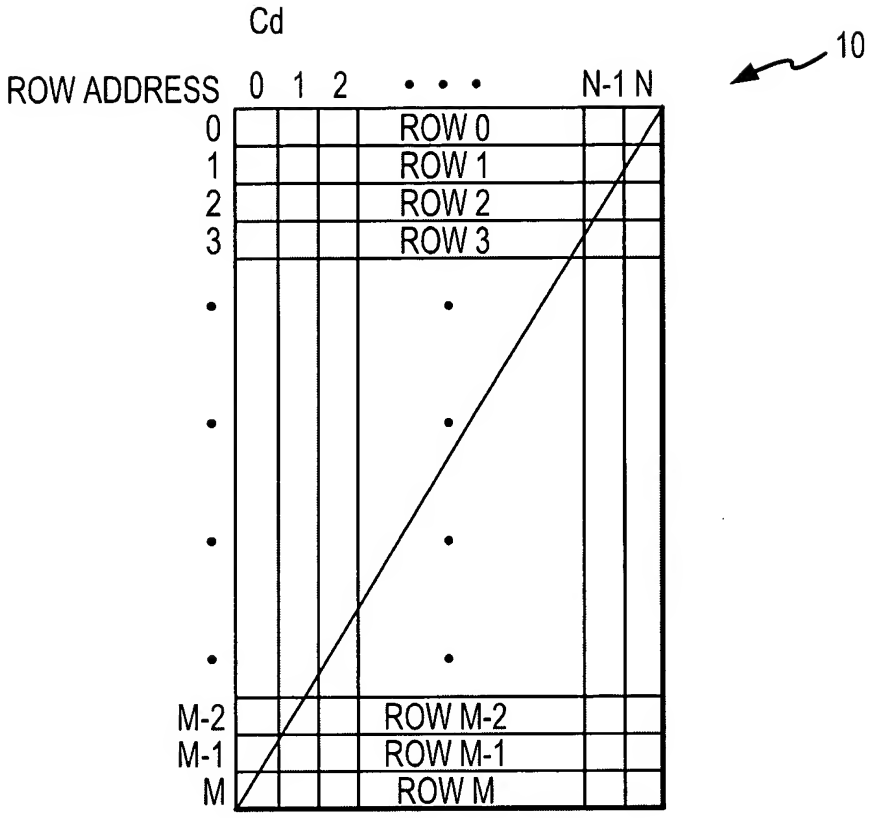

FIG.1
(PRIOR ART)

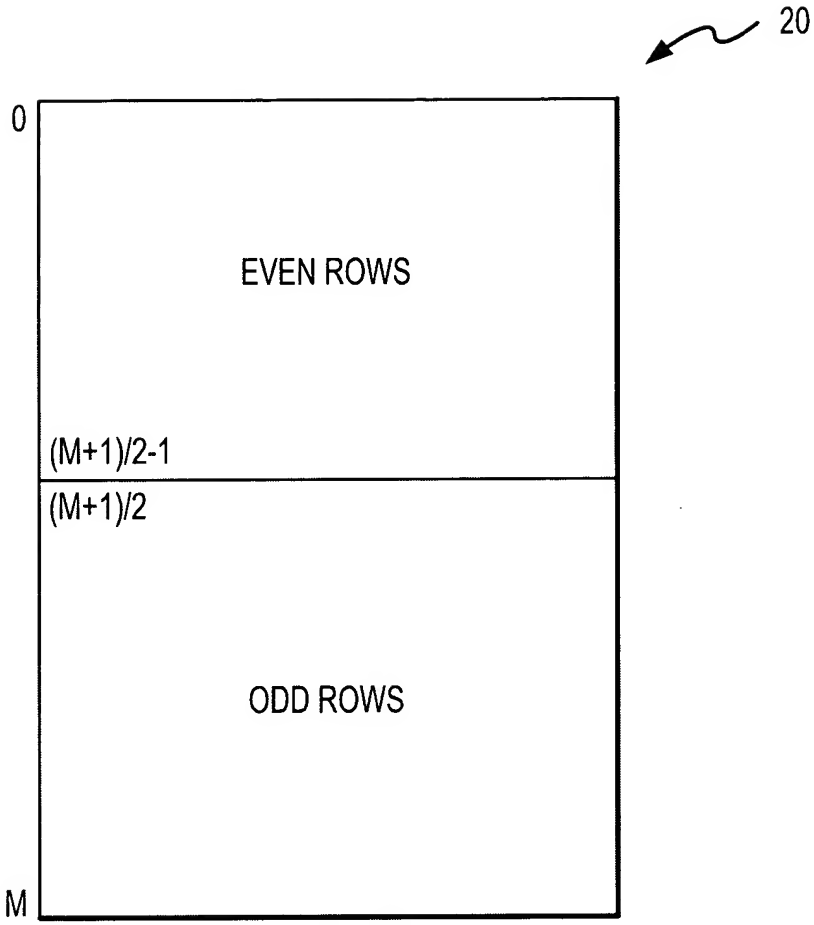

FIG.2

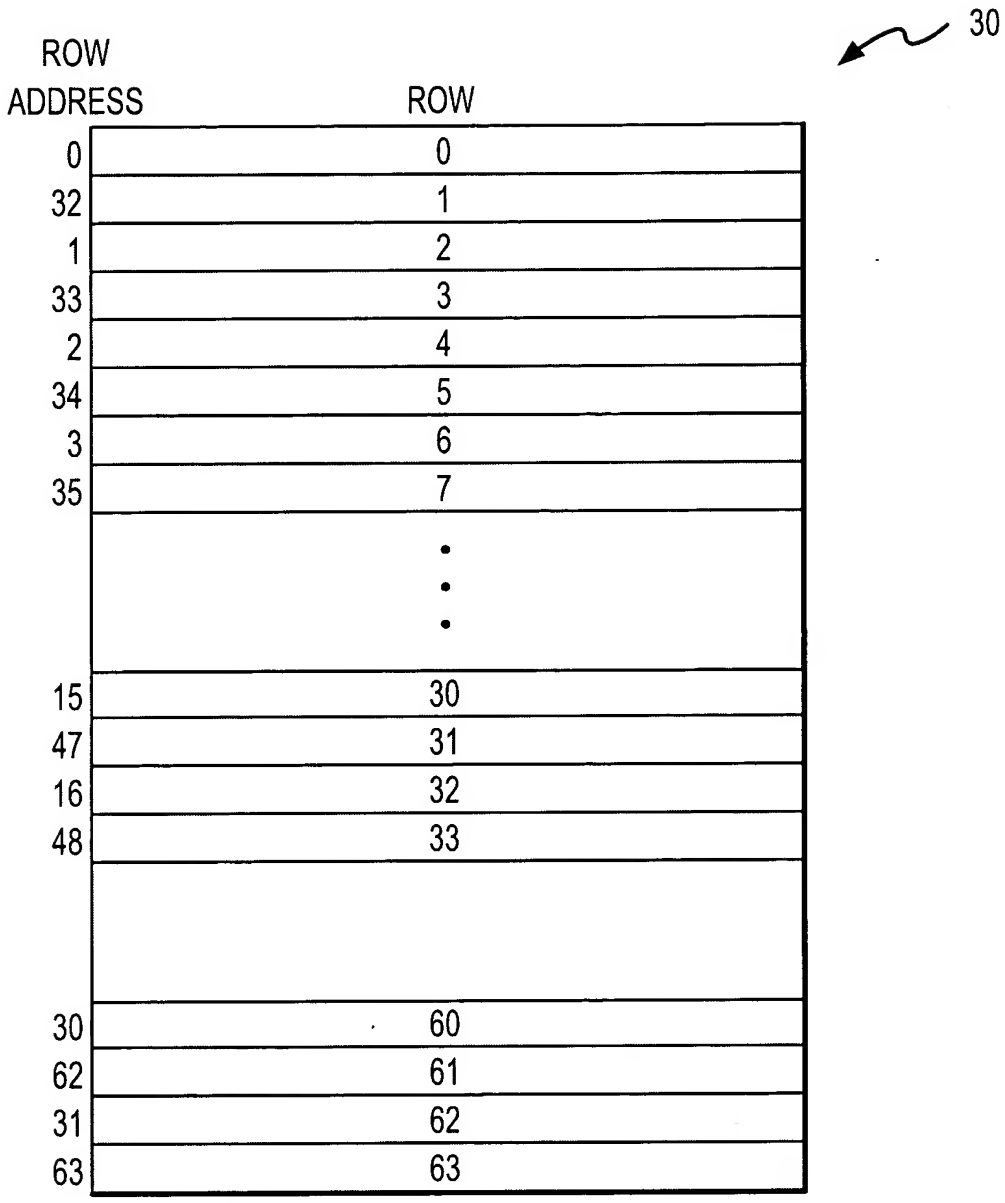
30
ROW ADDRESS
ROW
0
0
32
1
1
2
33
3
2
4
34
5
3
6
35
7
15
30
47
31
16
32
48
33
30
60
62
61
31
62
63
63

FIG.3

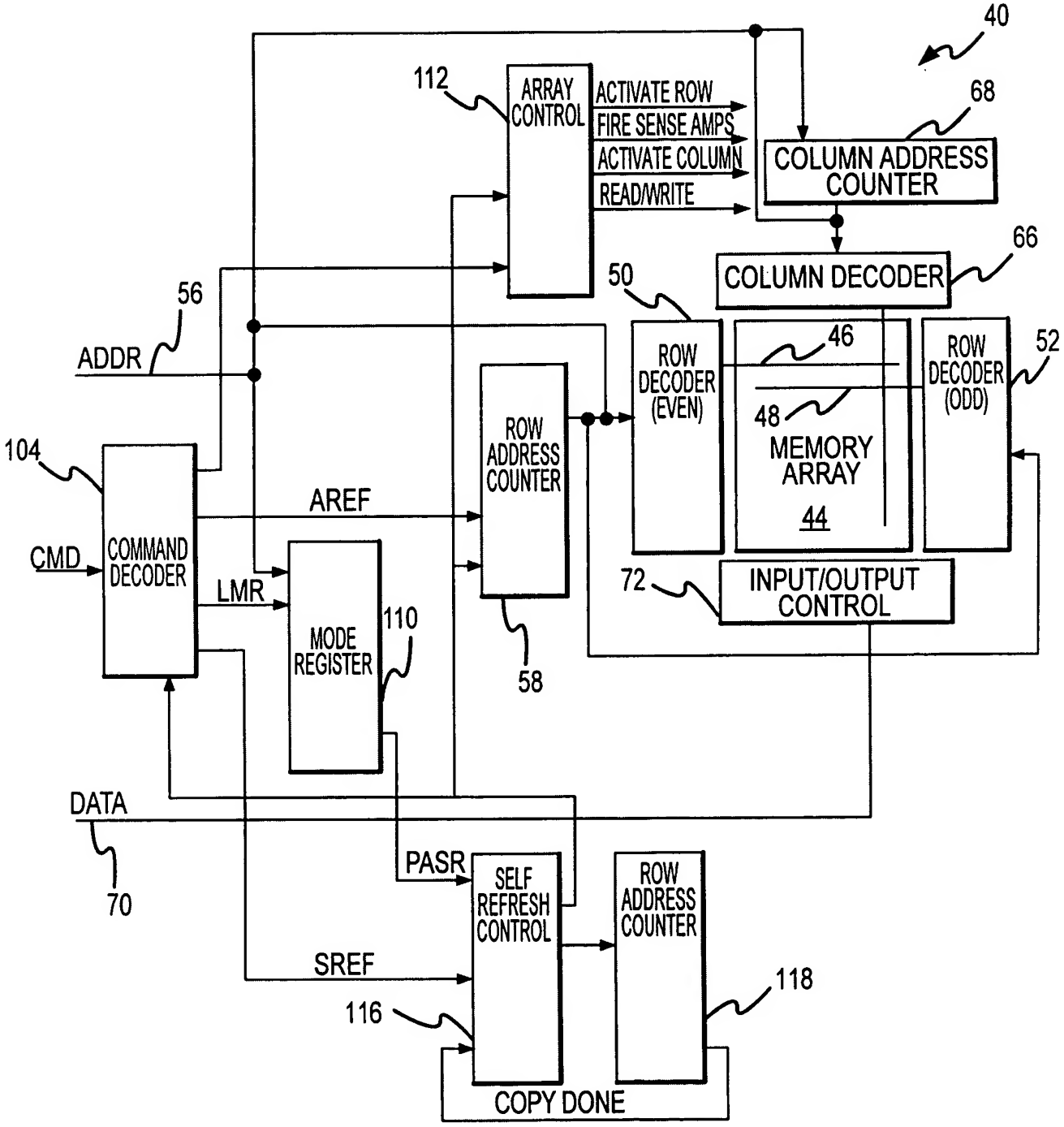
40
112
ARRAY CONTROL
ACTIVATE ROW
FIRE SENSE AMPS
ACTIVATE COLUMN
READ/WRITE
68
COLUMN ADDRESS COUNTER
66
COLUMN DECODER
50
56
ADDR
ROW DECODER (EVEN)
46
48
MEMORY ARRAY
44
ROW DECODER (ODD)
52
104
ROW ADDRESS COUNTER
AREF
CMD
COMMAND DECODER
LMR
MODE REGISTER
110
58
72
INPUT/OUTPUT CONTROL
DATA
70
PASR
SELF REFRESH CONTROL
ROW ADDRESS COUNTER
SREF
116
118
COPY DONE

FIG.4

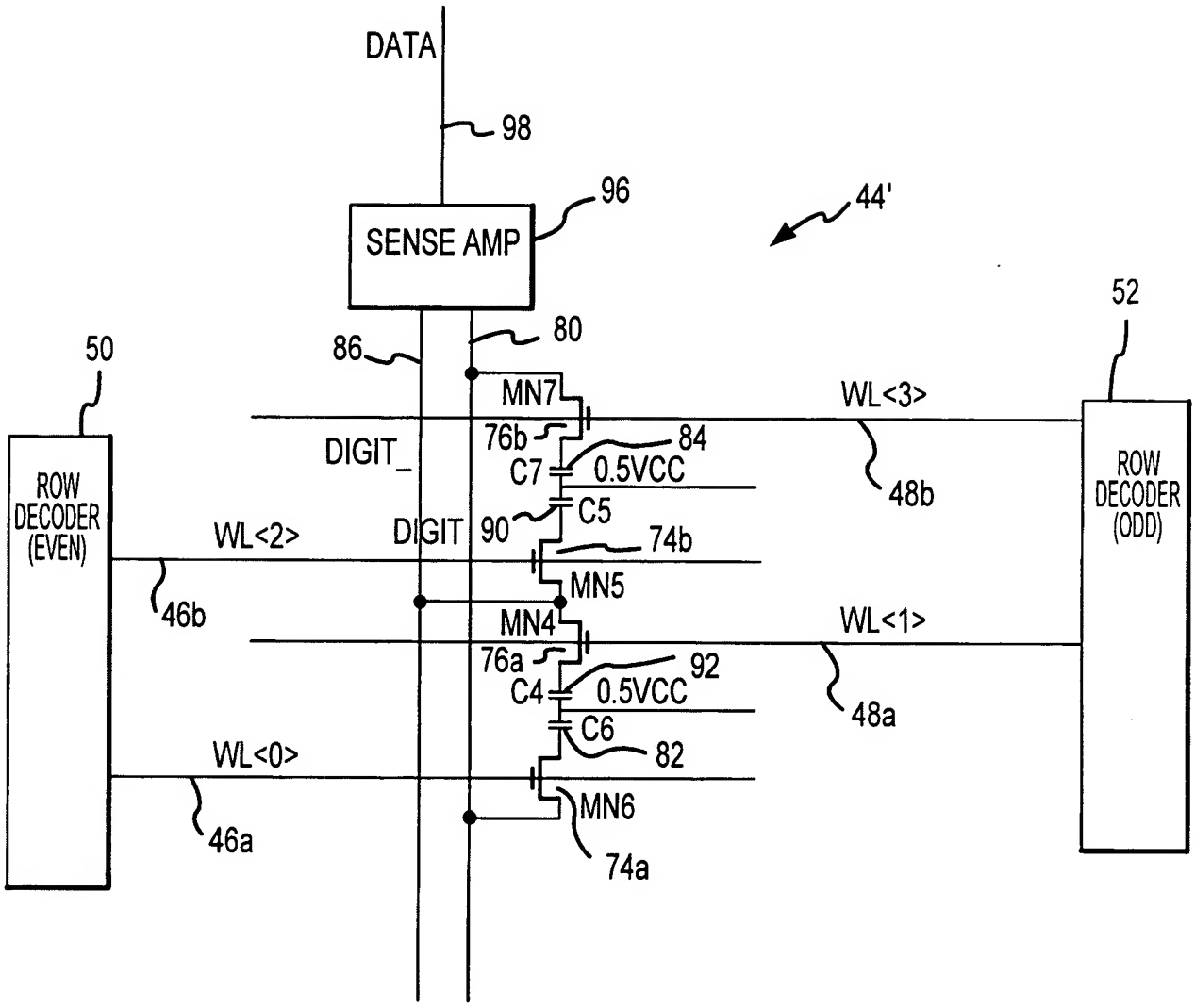
DATA
98
96
SENSE AMP
44'
52
50
86
80
MN7
WL<3>
76b
84
DIGIT_
C7
0.5VCC
48b
ROW DECODER (EVEN)
C5
WL<2>
DIGIT
90
74b
MN5
46b
MN4
WL<1>
76a
92
C4
0.5VCC
48a
C6
82
WL<0>
MN6
46a
74a
ROW DECODER (ODD)

FIG.5

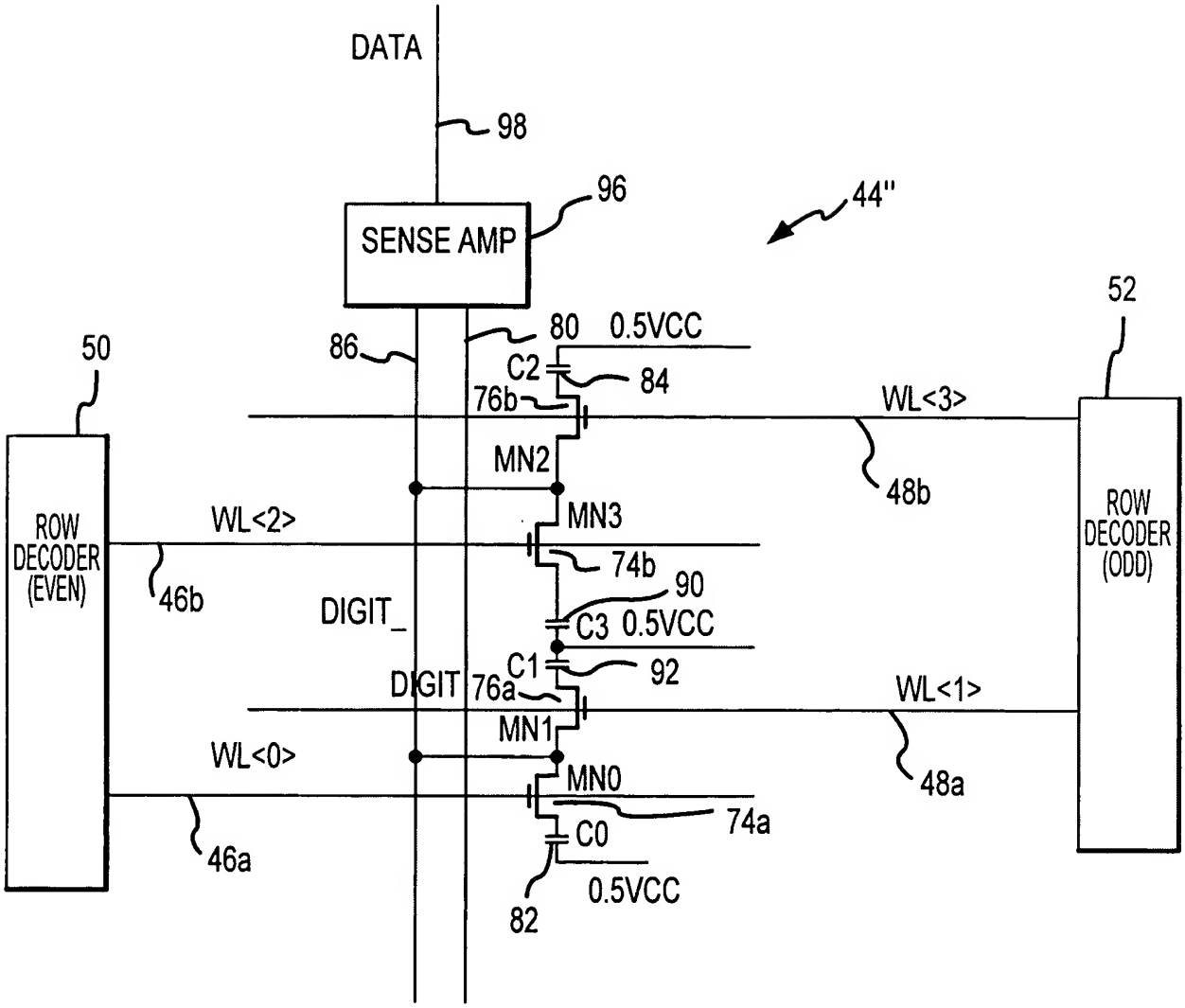
DATA
98
96
SENSE AMP
44"
52
50
86
80
0.5VCC
C2
84
76b
WL<3>
MN2
48b
ROW DECODER (EVEN)
WL<2>
MN3
ROW DECODER (ODD)
74b
90
46b
DIGIT_
C3
0.5VCC
C1
92
DIGIT
76a
WL<1>
MN1
WL<0>
48a
MN0
74a
C0
46a
0.5VCC
82

FIG.6

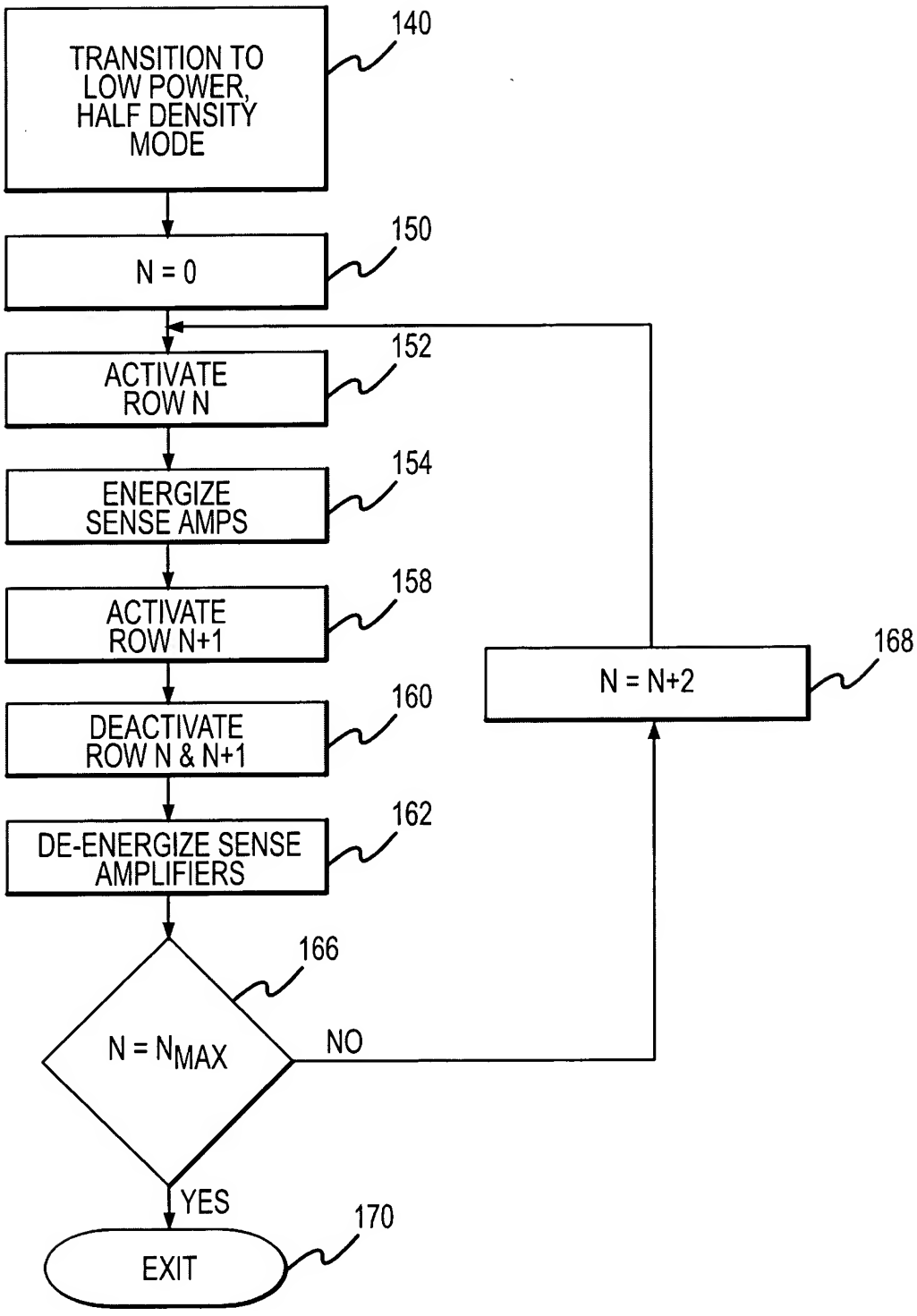
TRANSITION TO LOW POWER, HALF DENSITY MODE
140
N = 0
150
ACTIVATE ROW N
152
ENERGIZE SENSE AMPS
154
ACTIVATE ROW N+1
158
DEACTIVATE ROW N & N+1
160
DE-ENERGIZE SENSE AMPLIFIERS
162
N = N_MAX
166
NO
YES
EXIT
170
N = N+2
168

FIG.7

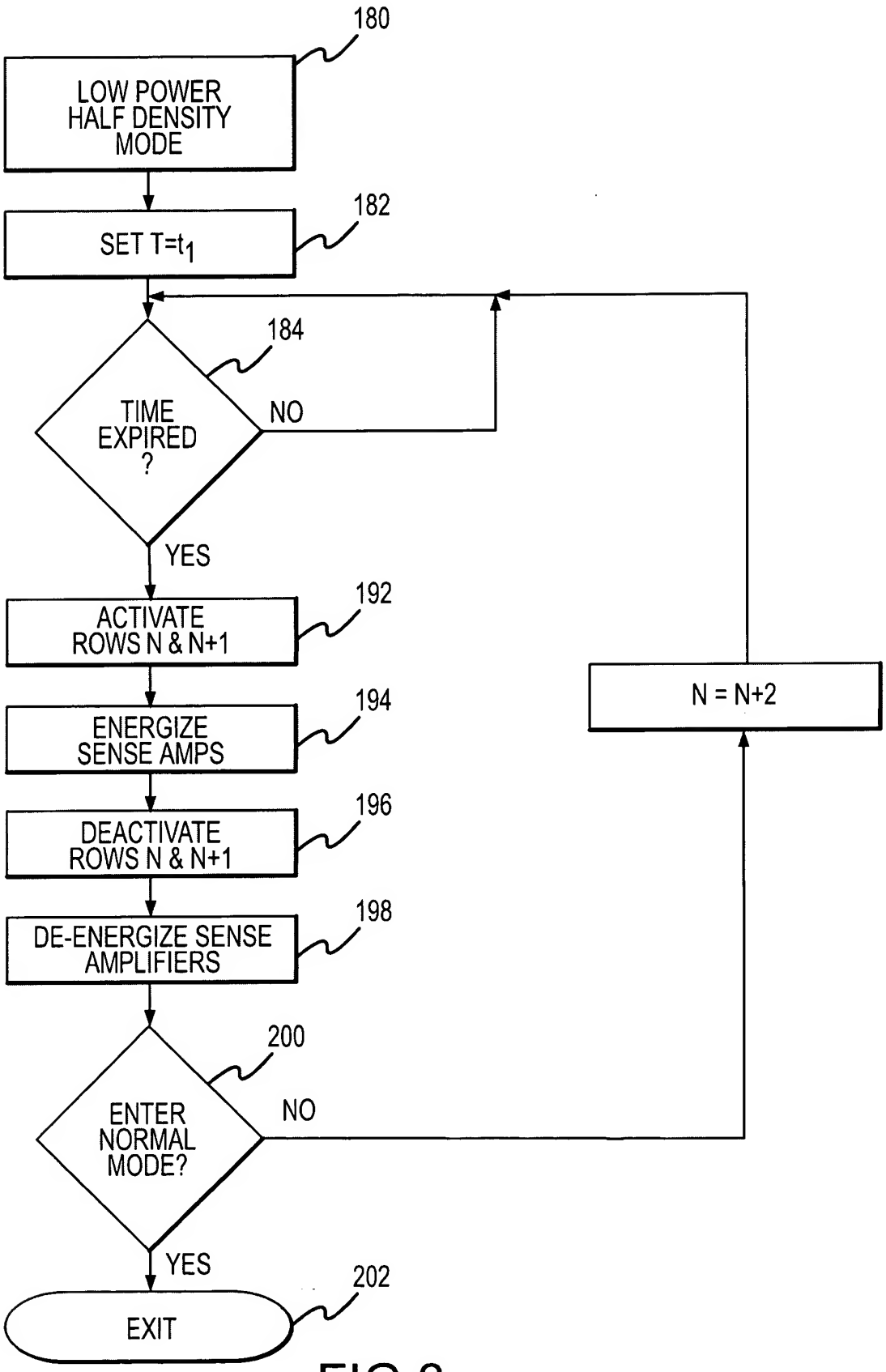
180
LOW POWER HALF DENSITY MODE
182
SET T=t1
184
TIME EXPIRED ?
NO
YES
192
ACTIVATE ROWS N & N+1
194
ENERGIZE SENSE AMPS
196
DEACTIVATE ROWS N & N+1
198
DE-ENERGIZE SENSE AMPLIFIERS
200
ENTER NORMAL MODE?
NO
YES
202
EXIT
N = N+2

FIG.8

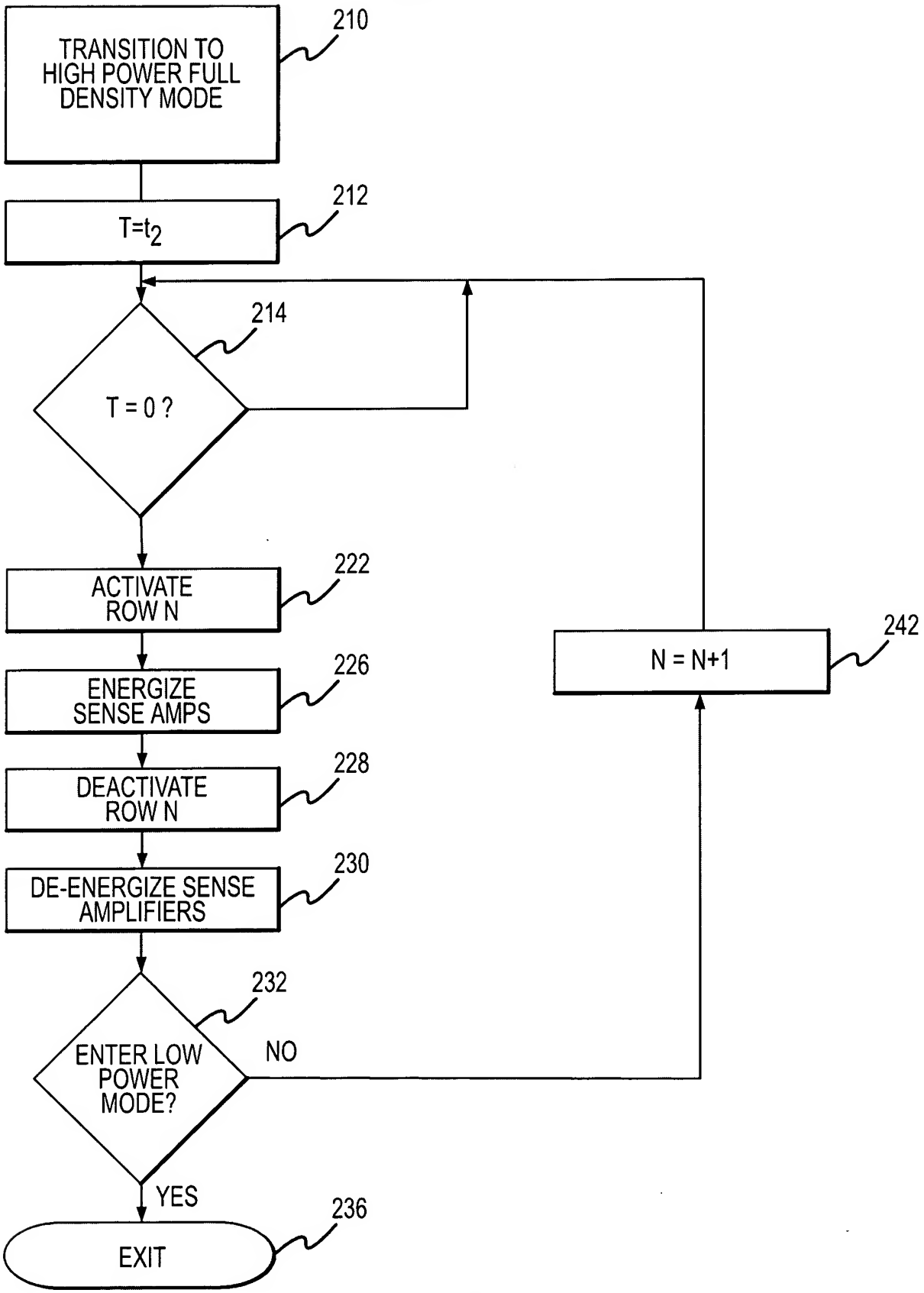
TRANSITION TO HIGH POWER FULL DENSITY MODE
210
T=t2
212
T = 0 ?
214
ACTIVATE ROW N
222
ENERGIZE SENSE AMPS
226
DEACTIVATE ROW N
228
DE-ENERGIZE SENSE AMPLIFIERS
230
ENTER LOW POWER MODE?
232
NO
YES
EXIT
236
N = N+1
242

FIG.9

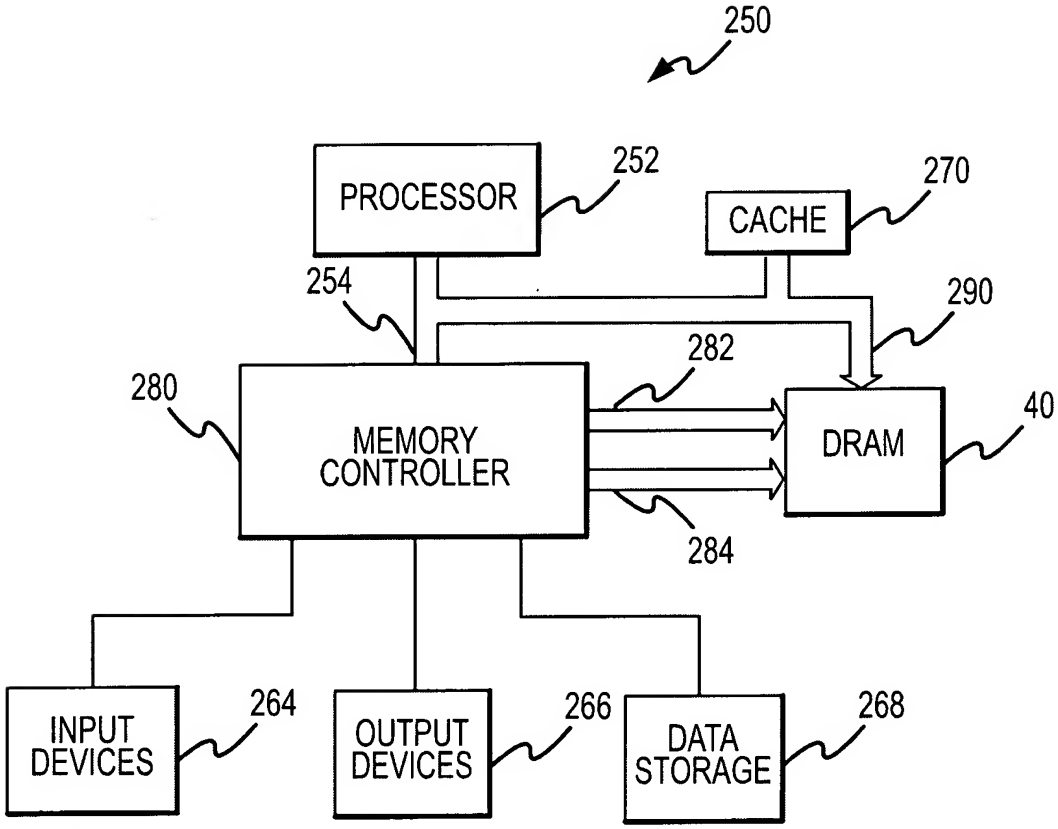
250
PROCESSOR
252
CACHE
270
254
290
282
280
MEMORY CONTROLLER
DRAM
40
284
INPUT DEVICES
264
OUTPUT DEVICES
266
DATA STORAGE
268

FIG.10